COMSECY-06-0064

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

REQUEST REPLY BY: 1/8/07

SECRETARY

December 21, 2006

[redacted]

MEMORANDUM FOR: Chairman Klein
Commissioner McGaffigan
Commissioner Merrifield
Commissioner Jaczko
Commissioner Lyons

FROM: Annette Vietti-Cook, Secretary

SUBJECT: COMSECY-06-0064 - STATE OF THE ART REACTOR CONSEQUENCE ANALYSIS COMMUNICATIONS PLAN

At the request of Chairman Klein, we have converted the subject memorandum from the Assistant for Operations, dated 12/18/06, to a COMSECY for formal Commission vote. Please reply to SECY by COB Monday, January 8, 2007.

Attachments:
As stated

cc: EDO
OGC
OCA
OPA
CFO

[redacted]

4/1

~~SENSITIVE~~
~~INFORMATION~~

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 18, 2006

NOTE TO COMMISSIONERS' ASSISTANTS

| OCM/DEK | OCM/EXM | OCM/JSM |
|---|---|---|
| cc Paul Dickman | __ Jeffry Sharkey | __ Spiros Droggitis |
| cc David Skeen | __ David Cummings | __ John Thoma |
| __ Roger Davis | X James Beall | __ Sara Brock |
| X Samuel Lee | __ Dave Brown | X Frank Akstulewicz |
| __ Bill Orders | __ Linda Lewis | __ Lorna Kipfer |
| __ Nancy Fragoyannis | __ Antoinette Lewis | __ Tojuana Fortune |
| __ Pat Castleman | | |
| __ Doug Broaddus | OCM/GBJ | OCM/PBL |
| __ Patti Silva | | |
| __ Clare Kasputys | __ Josh Batkin | __ Josie Piccone |
| __ Robert McOsker | __ Angela Coggins | __ Cathy Marco |
| __ Vicki Bolling | X Tom Hipschman | X Doug Coe |
| __ Linda Herr | __ Greg Hatchett | __ Steve Baggett |
| __ Kia Jackson | __ Jackie Raines | __ Vicki Ibarra |
| __ Yessie Correa | __ Carolyn Harves | __ Carrie Crawford |

FROM: Michael R. Johnson
Assistant for Operations, OEDO

SUBJECT: STATE OF THE ART REACTOR CONSEQUENCE ANALYSIS COMMUNICATION PLAN

The subject communication plan has been placed into ADAMS at ML063400286, for use by the staff. The State of the Art Reactor Consequence Analyses (SOARCA) project is being undertaken to develop a best estimate of the risks to public health and safety associated with the unlikely event of severe accidents for operating nuclear power plants using a set of risk-informed scenarios. In anticipation of potential inquires from public interest groups, media, and potentially Congress, the staff prepared the plan to provide a means for the NRC to be responsive to inquiries from internal and external stakeholders who request additional information regarding the SOARCA.

Enclosures:
ML063400473 Memo
ML063390657 Communication Plan
ML063400551 Web Page
ML063400554 Questions and Answers
ML063410189 Fact sheet
ML063410178 Press Release

cc: L. Reyes, EDO (w/o enclosures)
M. Virgilio, DEDMRT (w/o enclosures)
W. Kane, DEDR (w/o enclosures)
J. Silber, DEDIA (w/o enclosures)
M. Johnson, AO (w/enclosures)
C. Miller, OEDO (w/o enclosures)
T. Bloomer, OEDO (w/enclosures)
L. Rakovan, OEDO (w/enclosures)
J. Yerokun, RES (w/o enclosures)
B. Sheron, RES (w/o enclosures)
SECY (w/enclosures)
OGC (w/enclosures)
OCA (w/o enclosures)
OPA (w/o enclosures)
OIP (w/o enclosures)
OIS (w/o enclosures)
CFO (w/o enclosures)
EDO R/F (w/enclosures)

~~SENSITIVE~~
~~INFORMATION~~

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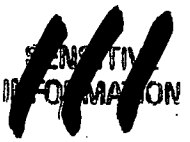

December 8, 2006

MEMORANDUM TO: Michael R. Johnson
Assistant for Operations
Office of Executive Director for Operations

FROM: Brian W. Sheron, Director */RA/* James T. Wiggins for
Office of Nuclear Regulatory Research

SUBJECT: STATE-OF-THE-ART REACTOR CONSEQUENCES ANALYSES COMMUNICATION PLAN REVISION 1

The purpose of this memorandum is to transmit revision 1 of the State-of-the-Art Reactor Consequence Analyses (SOAR-CA) Communication Plan (enclosure 1), in accordance with the requirements of OEDO Procedure 0430, Communication Plans. This revision breaks down the key messages of the plan into general messages, which contain very basic statements, and additional information for a more technical audience.

Included with this memorandum are the proposed external webpage for the SOAR-CA project (enclosure 2); a list of frequently asked questions and answers to the questions (enclosure 3); fact sheet for the project (enclosure 4); and a press release that has not yet been released, but has been approved by the Chairman (enclosure 5).

The initial revision of the SOAR-CA Communication Plan was provided to you in November 2006 (ML062960240). Since then, the staff have briefed the Chairman and Commissioner Peter B. Lyons on the project and are scheduled for a semi-annual Commission Assistants briefing at the end of this month. The staff have also briefed the SOAR-CA Steering Committee and the Advisory Committee on Reactor Safeguards (ACRS) on some of the technical issues.

The Office of Public Affairs (OPA) has reviewed and commented on this communication plan, and the staff incorporated the OPA comments into the enclosed final version.

CONTACT: Jimi Yerokun, RES
301-415-0585

Enclosures:
1. Communication Plan for the SOAR-CA Rev. 1
2. SOAR-CA Public Website
3. SOAR-CA Frequently Asked Questions and Answers
4. OPA Fact Sheet, SOAR-CA
5. OPA Press Release

[redacted]

# COMMUNICATION PLAN
# For
# The State-of-the-Art Reactor Consequence Analyses
# Revision 1

## Objective of the Project

The objective of the State-of-the-Art Reactor Consequence Analyses (SOAR-CA) project is to develop a best estimate of the risks to public health and safety associated with the unlikely event of severe accidents for operating nuclear power plants using a set of risk-informed scenarios.

## Goal

The goal of this communication plan is to ensure that the information developed by the SOAR-CA Project is communicated clearly and in such a way that it will not be misinterpreted by the public and other stakeholders. Implementation of this plan will facilitate increasing public understanding of the project and its results.

## Key Messages

General Messages

- Commercial nuclear power plants are safe and are designed to prevent accidents and to protect the public should an accident occur.
- Over the last 20+ years, utilities have improved their plant designs and operations, inspection methods, operator training, and emergency preparedness. All of these changes have increased overall nuclear power plant safety.
- The NRC examines potential health effects from accidents to ensure the agency continues protecting people and the environment.
- A small number of unlikely accidents, could potentially release radioactive materials to the environment, and the NRC would like to understand the consequences of such accidents.

Additional Messages

- Information developed over years of research have been incorporated into the tools that the NRC uses to evaluate hypothetical accidents. These tools are the Standardized Plant Analysis Risk (SPAR), MELCOR, and MELCOR Accident Consequence Code System, Version 2, (MACCS2) computer codes. These codes will be used to select the hypothetical accidents to be evaluated, to predict how nuclear power plant system and operators would respond, and to produce a best estimate of the potential offsite consequences. All operating nuclear power plants will be evaluated.



[redacted]

- The focus of this study are those accidents estimated to have at least a one in a million chance of damaging the reactor fuel (a core damage frequency of $10^{-6}$ per reactor-year). The SPAR code will be used to select the accidents for further evaluation.

- Plant specific MELCOR analysis will reflect design-specific features, based on major plant classes[1] of boiling and pressurized water reactors. MELCOR will be used to determine the nuclear power plant behavior, the progression of the accident, and the radioactive material released into the environment. This includes the timing of the fuel damage, component failures, and releases to the environment.

- MACCS2 calculations will use site-specific actions, emergency planning, weather data, population data, and evacuation times to estimate consequences, such as early and latent cancer fatalities.

- The results of this consequence assessment will provide stakeholders and other government agencies a more realistic picture and a better understanding of potential consequences from these accidents. Potential regulatory uses include more informed decision-making and enhanced interactions with the other government agencies. The NRC may use the results of this research study to aid in making decisions related to the safety of the public.

- The staff will continue to keep the tools current with emerging information, i.e., state-of-the-art.

## BACKGROUND

Several studies evaluating the likelihood of hypothetical accidents and the potential effects of those accidents have been previously performed. Each study was performed using the then state-of-the-art capabilities, both in knowledge and computational tools used. The enhanced knowledge and computational capabilities developed over the last 20+ years will allow more precise evaluations of plant response, operator actions, chemical interactions, radioactive material transport, and offsite consequences.

This study plans to use state-of-the-art information and calculational tools to develop best estimate radioactive material released into the environment based on the reactor/containment classes and assess those releases to determine best estimate offsite radiological consequences (e.g., early and latent fatalities) including uncertainties in those results. Some areas to be considered in these new assessments include: (1) design-specific reactor accident sequence progression, (2) design-specific containment failure timing, location, and size, (2) site-specific emergency planning assumptions, (3) any justifiable credit for operator actions based on Emergency Operating Procedures (EOPs) and Severe Accident Management Guidelines (SAMGs), and (4) site-specific meteorological conditions and updated population data.

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[1] The reactors (and their containments) will be grouped into classes based on similar design features and characteristics. The accident progression assessments will be performed on selected postulated severe accident scenarios.

SPAR models of representative plants will be used to determine the sequences and initiating events that should be considered for inclusion in the study. Scenario selection will be based on an estimated release frequency of $10^{-6}$ per reactor-year (one in a million). Other scenarios may be included, e.g., scenarios that are consequence significant but of a lower likelihood of occurrence. Insights gained from NRC research programs on containment performance and severe accident phenomena will also be incorporated. The MELCOR code will be used to estimate the radioactive material released into the environment for each scenario. The MELCOR analyses will credit mitigation measures, such as those contained in the EOPs and SAMGs. Operator actions will also be included to provide a realistic view of possible mitigation strategies. Finally, with regard to the offsite consequences, the MACCS2 code will be used to generate sitespecific consequence estimates that account for site-specific weather conditions, population distribution, and emergency planning assumptions. The SOAR-CA will use realistic, best estimate methods with quantified uncertainty assessments to represent the state-of-the-art knowledge in consequence assessment.

**COMMUNICATION TEAM**

The communications team associated with this plan will facilitate the communication of project activities.

| | |
|---|---|
| Team Manager: | Jimi Yerokun, RES |
| Team Members: | Robert Prato, RES<br>Charles Tinkler, RES<br>Paulette Torres, RES<br>Scott Burnell, OPA<br>TBD, OCA<br>TBD State Liasion, FSME<br>Lance Rakovan, OEDO |

As the project progresses, it is expected that other NRC staff will participate in the team as needed.

**AUDIENCES**

External Stakeholders

- General public
- Public interest groups
- Media
- Congress
- Licensees
- Nuclear industry organizations (e.g. NEI, INPO, EPRI)
- Department of Homeland Security
- State regulators
- International groups Internal Stakeholders
- Commissioners
- NRC Staff

Internal Stakeholders
- Commissioners
- NRC Staff

**COMMUNICATION TOOLS**

The following tools will be used to communicate with external stakeholders:

- Public Web Site: The status of the project will be placed on the external web site and updated every six months.
- Q&A's: Summaries of the key points in the project as well as basic Questions and answers about the project will also be included on the external website. This information will be focused toward the general public who may have an interest in following the project.
- Fact Sheet The fact sheet will provide the public with an overview of the project. The fact sheet is expected to be updated periodically to keep the public informed.
- Public Meetings: All public meetings related to the project will be posted to the external website. Meetings with other credible sources (i.e. external peer review, etc.) will be announced to address the issue of trust and credibility.
- Press Releases: A press release will be issued for public meetings, as needed, at least one week prior to the meeting. Press releases will be coordinated with the Office of Public Affairs. A press release will be issued at the end of the project when the results are available.
- Technical and Regulatory Documents: The final results documented in a NUREG or NUREG/CR will be made publicly available through ADAMS and the NRC's external website.
- Briefings: Briefings will be provided to Congressional and State stakeholders, if requested.

The following additional tools will be used to communicate with internal stakeholders:

- Internal Briefings: Internal briefings will be conducted at various points in the project to keep the SOAR-CA Steering Committee, Advisory Committee on Reactor Safeguards (ACRS), and NRC senior management informed of the staff's activities and to solicit project feedback. Meetings will be arranged for headquarters and regional staff as necessary to keep internal stakeholders informed. An Office on Nuclear Regulatory Research Monthly Seminar will also be held.
- NRC Reporter: A summary of the project may be submitted to the NRC Reporter, as necessary, during the course of the project's progress.

## MILESTONES OF INTERNAL AND EXTERNAL COMMUNICATION ACTIVITIES

| COMMUNICATION ACTIVITIES | RESPONSIBILITY | DATE |
|---|---|---|
| Meeting with Steering Committee (Topic - Introduction) | SOAR Team | June 29, 2006 |
| Meeting with ACRS (Closed Meeting) (Main Topic – Introduction, Accident Selection Scenarios, and Source Term / Consequence Analysis) | SOAR Team | July 13, 2006 |
| Meeting with DEDO (Main Topic - Project Overview and Status) | Michele Laur | August 15, 2006 |
| Expert review meeting on MELCOR & MACCS2 | Michele Laur | August 21-24, 2006 |
| Meeting with ACRS (Main Topic – Introduction, Accident Selection Scenarios, and Source Term / Consequence Analysis) | SOAR Team | September 7, 2006 |
| Public meeting with NEI and EPRI (Category 2) (Main Topic: Overview) | SOAR Team | September 8, 2006 |
| Public Meeting with Six Lead Plants (Category 1) (Main Topic: Overview & Scenario Selection) | SOAR Team | October 25, 2006 |
| Communication Plan approved and available | Robert Prato | November 2006 |
| Meeting with Steering Committee (Topic - Scenarios and Pilot Plant Selection) | SOAR Team | November 2006 |
| ACRS Meeting | SOAR Team | December 2006 |
| Internal Q&A's available | SOAR Team | December 2006 |
| Public website availability | SOAR Team | December 2006* |
| Post Q&A's on the website | SOAR Team | December 2006* |
| DEDO Brief | Robert Prato | December 19, 2006 |
| Meeting with Commission TAs | Robert Prato | December 20, 2006 |
| Meeting with Steering Committee (Main Topic– preliminary results from plant assessment) | SOAR Team | TBD 2007 |
| Commission paper (Main topic - Land contamination) | Robert Prato | March 2007 |

* The NRC's Office of Information Sevices (OIS) has a project underway to revise and update the NRC's public website. As such, the schedule for revising the NRC's website to include information on the SOAR-CA is subject to change. Initial feedback is that a delay of four or more months is possible.

| COMMUNICATION ACTIVITIES | RESPONSIBILITY | DATE |
|---|---|---|
| Update Communication Plan | SOAR Team | April 2007 |
| Public website update | SOAR Team | April 2007* |
| Meeting with ACRS (Main Topic– preliminary results from plant assessment) | SOAR Team | TBD 2007 |
| Meeting with Steering Committee (Main Topic– preliminary results from other plants assessed) | SOAR Team | TBD 2009 |
| Meeting with ACRS (Main Topic– preliminary results from other plants assessed) | SOAR Team | TBD 2009 |
| RES Monthly Seminar | SOAR Team | TBD |
| Internal Peer Review of documents | SOAR Team | TBD |
| Other meetings with licensee or industry | SOAR Team | TBD |
| Final Press Release | SOAR Team | TBD |
| NUREG or NUREG/CR | SOAR Team and/or SNL | TBD 2009 |
| Regulatory document availability | SOAR Team | TBD |

## EVALUATION AND MONITORING

A designated observer will attend meetings to document key questions and concerns. These observations and insights will be disseminated to all communicators on the team. The communication plan will be updated to reflect key ideas being communicated to stakeholders and key decision points in the project's progress. Communication from these venues will be reflected in responses to key questions and ideas during the project's progress.

* The NRC's Office of Information Sevices (OIS) has a project underway to revise and update the NRC's public website. As such, the schedule for revising the NRC's website to include information on the SOAR-CA is subject to change. Initial feedback is that a delay of four or more months is possible.

State-of-the-Art Reactor Consequence Analyses (SOAR-CA)
Frequently Asked Questions and Answers (Q's & A's)
OEDO Revision - 12/13/06

Q.1) What is the State of the Art Reactor Consequences Analyses (SOAR-CA) project?

A.1) The SOAR-CA project is a three-year effort to develop a realistic estimate of the risk involved in nuclear power plant accidents, where low-likelihood scenarios could release radioactive material to the environment and potentially cause offsite consequences. The project will also evaluate and improve, as appropriate, methods and models for realistically evaluating both the plant response during such severe accidents and the potential effects on the public.

Q.2) Why is the NRC performing this study?

A.2) Over the past 25 years, the NRC, industry and international nuclear safety organizations have completed substantial research on plant response to hypothetical accidents that could damage the core, as well as potential offsite effects from these accidents. That research has significantly improved our ability to analyze and predict how nuclear plant systems and operators would respond to severe accidents. During that same time, plant owners have improved the plant design, emergency procedures, inspection programs and operator training - all of which has improved plant safety. Emergency preparedness measures have also been refined and improved to further protect the public in the highly unlikely event of a severe accident. Applying this research, taking into account the enhancements to plant safety and emergency preparedness, will result in an improved and more realistic evaluation of both the probability and the consequences of severe accidents.

Q.3) How will this study improve upon earlier studies?

A.3) This updated realistic analysis, incorporating all the insights we have gained through research, can provide a better basis from which the public and decision makers can assess the safety of nuclear power plants. Modern computer resources and advanced software will reduce the need for conservative assumptions and will yield more realistic results. Past studies of plant response and offsite consequences were extremely conservative, to the point that the predictions were not useful for characterizing results or guiding public policy. Overly conservative results were often caused by either conservative assumptions or simple worst-case analyses. Misuse or misinterpretation of these earlier results further reinforces our belief that communication of risk from reactor accidents must be based on realistic analyses.

Q.4) What are the potential uses of the SOAR-CA study?

A.4) The overarching purpose of this study is to provide more realistic information on nuclear power plant risks to the public, stakeholders including federal, state and local authorities

and licensees, and the NRC. This study will increase understanding of the value of defense-in-depth features of plant design and operation, including mitigative strategies. This study will also replace some earlier studies, such as NUREG/CR- 2239, "Technical Guidance for Siting Criteria Development," dated December 1982, and NUREG/CR-2723, "Estimates of the Financial Consequences of Reactor Accidents," dated September 1982. Other uses could include potential improvements to regulatory analyses for backfitting decisions, prioritization and resolution of generic safety issues and resource allocation. This study will also provide insights to current emergency preparedness (EP) evacuation and sheltering strategies.

Q.5) Why were the six plants chosen for the initial set of studies?

A.5) Six plants are being selected for the first analysis so that the NRC can obtain early insights and experience with the analytical models, methods and assumptions used for the assessment prior to undertaking analysis of the entire fleet of reactors in the US. The initial assessments will help the NRC assess the study's analytical tools and methods, and help us decide if any revisions are necessary . The remaining U.S. nuclear power plants will be scheduled for subsequent evaluation.

The individual plants were chosen based on two major considerations. First, the plants are members of two of the largest generic groups of reactors: large Westinghouse pressurized water reactors with dry containments, and Mark I General Electric boiling water reactors. Secondly, the plants chosen represent a cross section of population densities. The six plants were not selected because of any concern over the potential consequences of a severe accident at that site.

Q.6) How will the SOAR-CA project be conducted?

A.6) Existing models will identify those accidents which have at least a one in a million chance per year of releasing radioactive material into the environment. This screening process is needed to avoid scenarios which have vanishingly small probabilities (one in ten billion reactor years or less). While it is mathematically possible to assign probabilities to such events, these events are so remote that any consequences associated with such events are not meaningful. After identification of the dominant severe accident scenarios, and the response of plant operators to those scenarios, detailed analyses will be performed with state-of-the-art analytical models to predict the plant response and offsite consequences.

Q.7) What is the basis for the state-of-the-art analyses?

A.7) The insights on severe accident phenomena accumulated through worldwide extensive experimental and analytical research over the last 25+ years has been incorporated into the MELCOR computer code. The MELCOR code, developed at Sandia National Laboratories, contains models for both active and passive plant features and the important physical processes associated with severe reactor accidents. MELCOR

analyses will be used to predict, in a consistent integrated fashion, the timing and progression of the severe accidents (e.g., timing of reactor core melt, timing of containment failure, and the magnitude of the radioactivity release to the environment).

Q.8) How is this state of the art analysis different from past analysis and evaluations?

A.8) Earlier studies, which did not have integrated analytical methods such as MELCOR available to them, often resorted to conservative assumptions (in some cases unrealistic and extremely conservative ones) regarding the timing and magnitude of radioactivity releases. Using the more realistic MELCOR prediction of radiation release, the study will then use the MACCS2 code to predict the offsite consequences of the radioactivity release. The MACCS2 code contains models for dispersion of radioactive plumes, emergency planning responses (evacuation and sheltering of the public) and uptake of radioactive material by the public and related health effects. Unlike some earlier studies which assumed a generic, emergency planning response, this new study will incorporate updated site-specific emergency planning in its prediction of potential offsite consequences.

Q.9) Why is it appropriate to use the criteria of one in a million chance per year for selection of accidents for analysis?

A.9) Realistic and risk-informed regulatory decisionmaking focuses on the value of preventive and mitigative features for the more likely scenarios. We will therefore conduct consequence analyses only for scenarios that have a radiological release frequency (due to containment failure or containment bypass) greater than or equal to one in a million per year of reactor operation.

The threshold value selected for screening individual scenarios represents a risk which is about 10 times smaller than the combined risk associated with the NRC's safety goal. Thus, in this study we are examining all of the events which would normally be important in a risk assessment.

Using such a criteria allows us to concentrate our resources and detailed analyses on those events which while remote, are more likely to realistically contribute to public risk. Scientific knowledge, combined with theoretical projections, allows us to assign probabilities to extremely remote events (e.g., massive destruction from meteors). But the estimate of the probability of such events is highly suspect since there is no human experience from which to judge the accuracy of such estimated probabilities. The study of unrealistically extreme events with incredibly low probabilities sheds no useful information on the safety of nuclear reactors. There is far greater value in focusing on events which bear some credibility. The particular probabilistic threshold value chosen for SOAR-CA is quite low and represents a minimal level of risk to the public.

Q.10) What consequence measures are being estimated?

A.10) This study assess the health effects of a potential radiation release on the general public. State-of-the-art analytical models will be used to estimate the number of prompt fatalities and the number of latent cancer fatalities that could occur in the remote event that a severe reactor accident occurs. Prompt fatalities are those resulting from exposure to very high doses of radiation as the result of a release. These fatalities occur soon after exposure (days to months). Latent cancer fatalities are those resulting from the long-term effect of radiation exposure. The estimates of public health effects in this new study will realistically account for the emergency planning measures in place at each reactor site, unlike some of the past studies which used overly conservative generic assumptions that did not account for site specific planning. Consistent with our overall approach, in order to more realistically estimate health effects, the prediction of latent cancers will account for a threshold dose (up to 5 rem per year) below which no observable health effects have been determined.

Q.11) Who is participating in the SOAR-CA project?

A.11) The SOAR-CA project is being performed by the NRC with assistance from Sandia National Laboratories. Sandia National Laboratories is the principal NRC contractor for severe reactor research and has developed much of the computer modeling to be used in this study. At NRC, the study is a joint effort among the Offices of Nuclear Regulatory Research, Nuclear Security and Incident Response, and Nuclear Reactor Regulation.

Performing the SOAR-CA project requires a wide array of disciplines. Staff working on the project include experts in reactor accident probabilistic assessment, human factors, severe core damage accident phenomena and modeling, emergency planning, and offsite consequences. Information will be required from all of the operating power plants to obtain realistic input for the calculations. Six plants (Peach Bottom, Duane Arnold, Seabrook, Fermi, Salem, and Diablo Canyon) will be asked to supply information during the first phase of the study. Information from the remaining plants will also be requested.

In addition to the NRC and its contractors participating on this project, peer reviewers of the results will include nuclear safety experts from a wide range of organizations. Independent experts from other national laboratories (e.g., Oak Ridge National Laboratory, Brookhaven National Laboratory) as well as industry experts and researchers from other countries participated in the initial assessment of the analytical methods.

Q.12) Are terrorist acts, such as aircraft impacts, being analyzed as part of SOAR-CA? (If so, how? If not, why not?)

A.12) No. The focus of this study is on normal operational scenarios that could potentially lead to radiological release to the environment. If there are important security related events which are not captured by the spectrum of scenarios identified from safety

analysis, they will be addressed separately from this analysis.

Q.13) Are spent fuel pools considered in this study?

A.13) No. Spent fuel pools are not considered in this study. The project is focused on evaluating the severe, and very unlikely, accidents that may occur at operating power reactors. Accidents that may occur as a result of the spent fuel pool occur much more slowly because there are much lower levels of energy (decay heat) involved. Such accidents therefore take longer to evolve and allow ample time for response by personnel to prevent any radiological release.

# State-of-the-Art Reactor Consequence Analysis (SOAR-CA)

**In Brief**

- The project's results will replace earlier studies that overestimated both the magnitude and consequences of possible nuclear power plant accidents
- 25 years of research and plant improvements guide the project
- SOAR-CA results for each reactor site will be publicly available at the end of the study

The NRC is conducting a three-year project to estimate the possible public health and safety consequences in the unlikely event of a commercial nuclear power plant accident releasing radioactive material into the environment. The agency has used accident assessment tools since their creation in the 1970s to help focus attention on reactor design and operational features that are most important to safety. SOAR-CA will take maximum advantage of hundreds of millions of dollars of national and international reactor safety research, as well as improved NRC regulatory requirements and nuclear industry initiatives over the past 25 years. The project's computer models and simulation tools will develop a set of realistic consequence estimates of very unlikely accidents at each U.S. reactor site. The NRC will use these results when considering future regulatory action. This kind of research into accident phenomena, such as core damage and containment performance, has provided the basis for industry procedures to mitigate such accidents. This project supports the NRC's strategic goal of openness in our regulatory process by making its results and supporting information publicly available in as understandable a form as possible. Stakeholders can then use this information when commenting on the agency's proposed actions.

## SOAR-CA's Plant-Specific Basis

The project will initially focus the plant-specific evaluations on event and failure scenarios with at least a one-in-a-million-years chance of radiological releases. This process will provide valuable experience in performing such evaluations and in using them for regulatory decision-making and communications. The results will be clearly presented to inform the public on the extent and value of safety defense features (i.e. defense-in-depth) and current mitigative strategies. This approach will be a substantial improvement over previous reactor siting studies and reports.

The results of each plant's analysis will be made public to the maximum extent possible and could assist a variety of regulatory decisions as noted above. The updated computer modeling tools and methods will continue to be available to address questions and issues that arise, providing valuable insights into possible solutions.

## SOAR-CA Process and Schedule

This study plans to use state-of-the-art information and calculation tools to develop best estimate radioactive material released into the environment based on the reactor/containment classes and assess those releases to determine best estimate offsite radiological consequences including uncertainties in those results. Some areas to be considered in these new assessments include: (1) design-specific reactor accident sequence progression, (2) design-specific containment failure timing, location, and size, (2) site-specific emergency planning assumptions, (3) any justifiable credit for operator actions based on Emergency Operating Procedures (EOPs) and Severe Accident Management Guidelines (SAMGs), and (4) site-specific meteorological conditions and updated population data.

SPAR models will be used to determine the sequences and initiating events that should be considered for inclusion in the study. Scenario selection will be based on an estimated release

frequency of $10^{-6}$ per reactor-year (one in a million). Insights gained from NRC research programs on containment performance and severe accident phenomena will also be incorporated. A computer code that models accident progression (MELCOR code) will be used to estimate the radioactive material released into the environment for each scenario. Finally, a computer code that models offsite consequences (MACCS2 code) will be used to generate site-specific consequence estimates that account for site-specific weather conditions, population distribution, and emergency planning assumptions. Accident progression and consequences will be developed for the sites with Mark I, Mark III, and Westinghouse large dry plants the 1st year; with Mark II, and ice condenser plants the 2nd year; and with CE and B&W plants the 3rd year. A combination of NRC and SNL staff will perform the work.

**SOAR-CA Background Information**

- Contact Us
- Frequently Asked Questions and Answers
- Meeting Notices
- Meeting Summaries
- Presentations
- Probabilistic Risk Analysis (PRA) and Severe Accident Modeling
- Related Information

# Fact Sheet

United States Nuclear Regulatory Commission
Office of Public Affairs
Washington, DC 20555
Telephone: 301/415-8200 E-mail: opa@nrc.gov



## STATE-OF-THE-ART REACTOR CONSEQUENCE ANALYSIS

**Background**

While nuclear power plant accidents are extremely unlikely, the NRC is launching a three-year project with the best available methods and computer codes to assess the possible consequences such accidents might have on public health and safety. The Nuclear Regulatory Commission has done considerable research over the past 25 years evaluating reactor accidents and how they could affect the public. This project will replace past studies that had significant uncertainties and did not include information on current plant design, operation, accident management strategies, emergency preparedness procedures or security enhancements.

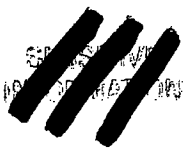
Earlier work was also limited by both computer hardware and software available at that time. Researchers attempted to overcome these shortcomings by simplifying some estimates or assumptions concerning possible damage to the reactor core, the possible radioactive contamination that could be released, and possible failures of the reactor vessel and containment

buildings. These efforts led to unrealistic overestimates in the results, particularly in one 1982 report (NUREG/CR-2239, "Technical Guidance for Siting Criteria Development") sometimes referred to as the "Sandia study." This report was meant to assist NRC staff in considering regulations for choosing nuclear power plant locations, but has been regularly misinterpreted and misused as an estimate of accident consequences.

Since those early studies, information from both NRC and cooperative foreign research has greatly increased our understanding of the timing and magnitude of possible radioactive releases from potential accidents at nuclear power plants. The NRC has also enhanced its ability to realistically model accident progression and emergency response. Information developed over the years has been incorporated into the agency's accident evaluation tools. These up-to-date research methods and tools will be used to more realistically calculate and evaluate accident progression, as well as the consequences of potential accidents.

**State-of-the-Art Reactor Consequence Analysis (SOAR-CA)**

The project will be conducted for all U.S. nuclear power plants and will be supported by the Sandia National Laboratories in Albuquerque, N.M. The results, replacing earlier research on reactor accident consequences, will be made available to the public and provide a better understanding of what might happen if an accident occurs. Using this information, emergency response procedures could then be altered to assure the best protection of public health and safety.



The SOARCA project will focus on a set of possible accident scenarios with at least a one-in-a-million chance per year of releasing radioactive contamination into the environment. The scenarios will be evaluated using two sets of computer codes called MELCOR and MACCS2. MELCOR models the evolution of potential severe accidents in a nuclear power plant, examining such processes as reactor fuel heatup and damage, chemical reactions and radioactive material release and transport. MELCOR also examines how reactor coolant systems, containment structures and other safety systems could perform under accident conditions. MELCOR's models are based on many U.S. and international experiments, as well as information from the Three Mile Island and Chernobyl accidents, and are updated and refined as new information becomes available. The MACCS2 code examines possible public health consequences from nuclear power plant accidents by calculating downwind transport, dispersion, and deposition of airborne radioactive material, accounting for weather conditions. The health consequences are calculated, taking into account protective measures such as evacuation and sheltering.

**Project Approach**

This project will be based on realistic scenarios for several broad categories of U.S. reactor designs. The study will use 25 years of severe accident research to determine the most likely severe accidents and their possible consequences. The MELCOR portion of the project will take into account improvements in plant design that could delay the release of radioactive contamination or otherwise lessen the impact of an accident. This portion will also model the performance of structures and buildings meant to prevent the spread of contamination, based on research that subjected these containment structures to severe accident conditions and extreme

stress. This part of the analysis will develop realistic estimates of whether or not contamination could reach the environment, and if so, how much could be released and how much time would pass until a release.

The next step in the project will incorporate information from each reactor site. A year's worth of meteorological data from each site will help MACCS2 determine how wind and weather conditions would affect the spread of contamination. Updated population data, combined with detailed analysis of the actions called for in every site's emergency plans, will be worked into the MACCS2 model to determine the most realistic estimates possible of the potential health and safety consequences of a reactor accident. The results of these analyses will be compiled in a public document to be released once the entire project is complete. The NRC will post updates on the project, relevant documents and the project's final results on its Web site at http://www.nrc.gov/what-we-do/regulatory/research/soar.html .

**Project Timeline**

The SOARCA project is broken down into three segments, by year. The first year will examine 46 plants, both boiling water reactors (BWRs) that use the General Electric Mark I and Mark III containment designs and pressurized water reactors (PWRs) that use the Westinghouse "four-loop" design in a "large, dry" containment. The second year will cover 37 plants, including BWRs with the General Electric Mark II design, PWRs with "ice condenser" containments and other Westinghouse plants. The final year will examine 21 plants with Babcock and Wilcox or Combustion Engineering PWR designs.

The NRC staff selected six plants to lead off the first-year analyses in 2007. The staff chose three Westinghouse PWRs (Seabrook in New Hampshire, Salem in New Jersey and Diablo Canyon in California) and three Mark I BWRs (Peach Bottom in Pennsylvania, Fermi in Michigan and Duane Arnold in Iowa) to provide a range of population densities for the analyses to take into account.

December 2006

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## NRC CREATES WEB PAGE ON

## STATE-OF-THE-ART REACTOR CONSEQUENCE ANALYSIS

The Nuclear Regulatory Commission has established a Web page to inform the public about its activities to update its consequence assessment of potential nuclear reactor accidents. The State-of-the-Art Reactor Consequence Analysis (SOARCA) will be used to realistically predict the consequences of potential accidents at each commercial reactor in the United States.

"Almost 25 years ago, we did a study that was purposely conservative for addressing reactor siting, and the results of that work have sometimes been misinterpreted and often misused," said Farouk Eltawila, Director of the Division of Risk Assessment and Special Projects in the NRC's Office of Nuclear Regulatory Research. "That study was extremely conservative, to the point that its predictions were not useful for characterizing results or guiding public policy. Today's computer-based analytical tools are much more capable of realistically evaluating the effects of potential nuclear power plant accidents, and this project will improve everyone's understanding of the realistic consequences of such potential accidents."

The page, available at http://www.nrc.gov/what-we-do/regulatory/research/soar.html, will include public meeting information, presentations by NRC staff, a frequently asked questions list and links to fact sheets and other SOARCA-related documents. The agency will periodically update the page as more information on the project becomes available.

While nuclear power plant accidents are extremely unlikely, it's nevertheless important to understand their possible consequences. The NRC's three-year project will analyze each U.S. nuclear power plant, incorporating more than 20 years of accident research to develop realistic estimates of possible consequences resulting from a potential accident. The analyses will then use site-specific weather and population data to determine the effects on public health and safety. The results of these analyses will be compiled in a public document to be released once the entire project is complete in 2009.

In the project's first year, the NRC will start with boiling water reactors that use the General Electric Mark I and Mark III containment designs, and pressurized water reactors that use the Westinghouse "four-loop" design in a "large, dry" containment. The NRC is currently working with six plants, three from each of the above categories, to ensure the analysis methods are sound. The intended lead plants are Diablo Canyon in California, Duane Arnold in Iowa, Fermi in Michigan, Seabrook in New Hampshire, Salem in New Jersey and Peach Bottom in Pennsylvania. The second year's analyses will cover General Electric Mark II plants, as well as "ice condenser" and other Westinghouse plants. The final year's analyses will include plants with Babcock & Wilcox and Combustion Engineering designs.

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